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Central and Arctic Region
Canadian Science Advisory Secretariat
Science Advisory Report 2016/007

ESTIMATES OF ABUNDANCE AND TOTAL ALLOWABLE REMOVALS FOR ATLANTIC WALRUS (*Odobenus rosmarus rosmarus*) IN FOXE BASIN

Atlantic walrus (Odobenus rosmarus rosmarus)
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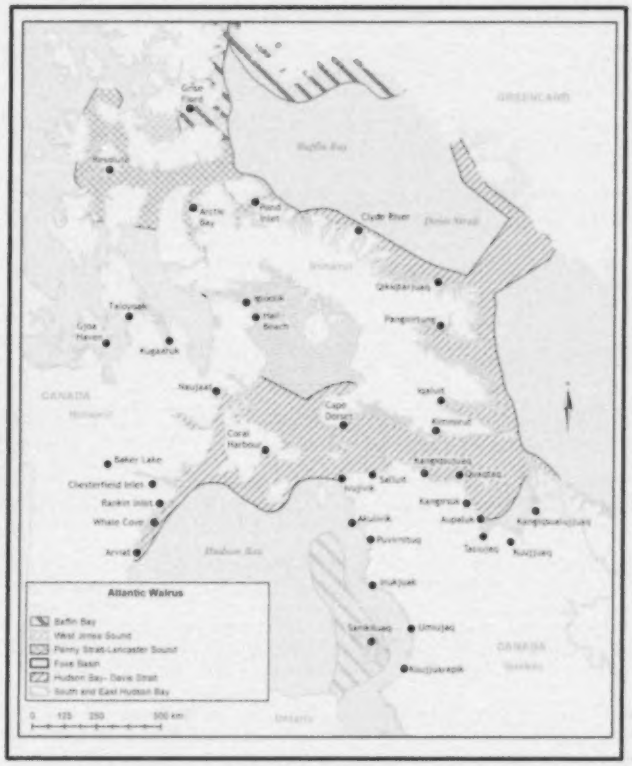

Figure 1. Location of Atlantic walrus stocks in the eastern Canadian Arctic. The stocks are Baffin Bay, West Jones Sound, Penny Strait-Lancaster Sound, North and Central Foxe Basin stocks, Hudson Strait-Davis Strait and South and East Hudson Bay stocks.

Context:

There are seven walrus stocks in the eastern Canadian Arctic. Increasing national and international attention regarding how Canada is managing these walrus stocks requires Fisheries and Oceans Canada (DFO) to be able to demonstrate a sustainable harvest or take appropriate actions if current harvesting is deemed unsustainable. A Science Advisory Report published in 2013 (DFO 2013) provided Total Allowable Removal (TAR) levels for four stocks, including Foxe Basin (FB) using the Potential Biological Removal (PBR) method. Based on that science advice, the current level of harvesting in FB exceeds the TAR. In March 2015, it was brought to the attention of DFO that there is some information from the late 1980s that may be useful in considering the stock trend of FB walrus, and therefore potentially influencing the recovery factor (F_R) used in calculating PBR for this stock.

June 2016

Canada

Objectives: To evaluate whether historic survey data can be compared or used to provide information on a trend in stock abundance for FB walrus. If the historical data are relevant for evaluating the FB stock trend, determine whether F_R = 0.5 is most appropriate or if it is appropriate to calculate PBR using a different F_R resulting in an updated range of TARs for this stock.

SUMMARY

- Walrus are a challenging species to enumerate owing to their aggregated distribution and correlated haulout behavior resulting in highly variable proportion of animals hauled out at one time.
- Several methods have been used to estimate walrus abundance. All methods that estimate the number of animals on land or ice require a correction factor to adjust the counts for animals that are in the water (not visible) when the surveys are completed.
- Based on a simulation study, the Simple Count (SC) method, using mean counts provides a reliable and unbiased estimate of the number of animals hauled out.
- Abundance information from surveys completed in 1983, 1988, and 1989 provided useful information on trends in walrus abundance in Foxe Basin.
- Abundance information from surveys flown in 2010 and 2011 were also re-examined using the Simple Count method. This resulted in an estimated population of 10,400 (SE=4,500) in 2010 and 14,100 (SE=6,700) in 2011.
- A surplus production population model that included reported harvest information was fitted to the Foxe Basin times series of abundance estimates, using Bayesian methods. One of the strengths of the Bayesian approach is that it provides a framework to account for uncertainty in model inputs.
- Model results showed that the stock has likely remained stable over the last 60+ years.
- The estimated population from the model in 1954 was 11,900 (95% Bayesian Credible Intervals (BCI) =10,200-17,900) and in 2014 was 12,500 (95% BCI=8,600-18,500). The reported harvests do not appear to be having an impact on the population as it appears to be stable. However, our ability to detect a decline is limited owing to the infrequency of surveys.
- Total allowable removals of walrus in Foxe Basin have been estimated using the Potential Biological Removal (PBR) method. In previous assessments, a maximum rate of increase (R_{max}) = 0.07 has been used. This review concluded that an R_{max} of 0.08 is more appropriate.
- In previous assessments, a recovery factor (F_R) of 0.5 has been used. In this assessment, advice using F_R=1 was also provided.
- A PBR estimate based on the estimated 2014 population size from the model was 211 or 422 using recovery factors of 0.5 or 1.0, respectively.
- The Foxe Basin stock was last surveyed in 2011. Model uncertainty increases with increasing time since the last survey, which affects our ability to evaluate the impact of harvesting on the population.
- The PBR calculation includes removals from all sources of human induced mortality. Current average reported harvests from this area are 170 animals per year, implying a total removal of 243, if a Struck and Lost value of 30% is assumed.

- A Precautionary Approach framework with clear management objectives is needed. This would allow for more risk-based advice to be provided. In the meantime, updating the model with new survey data and using model outputs to provide PBR estimates uses all of the scientific information in providing management advice.

INTRODUCTION

Walrus in the Canadian Arctic have been divided into two genetic populations and seven stocks (Figure 1) based on genetic, isotope, satellite tag, and elemental analysis. Two stocks, located in Foxe Basin, are managed as a single management unit. DFO Science has provided abundance estimates and sustainable harvest advice for the Baffin Bay (BB), Western Jones Sound (WJS) and Penny Strait-Lancaster Sound (PS-LS) stocks belonging to the high Arctic population (DFO 2013). Advice has also been provided for walruses in Foxe Basin and the southeast Baffin Island portion of the Hudson Bay-Davis Strait (HBDS) stock, belonging to the central Arctic population (DFO 2016a, DFO 2016b).

Walrus are widely distributed in the eastern Canadian Arctic and are most often found in aggregations of tens to thousands. The practice of using haulout counts to estimate stock size for walrus is thought to be an appropriate survey method but is not well developed. For that reason several approaches have been used to extract as much information as possible from the data. Data from satellite tags are also used to adjust the haulout counts to account for those animals missed by the survey.

Owing to limited survey data, walrus are considered data poor. DFO has used the Potential Biological Removal (PBR) method to develop advice about Total Allowable Removals (TAR) for marine mammals considered data poor. PBR refers to all human-caused mortality so estimating a TAR provides the level of removals from all human-caused mortalities that should allow the population to maintain its optimal population size or grow to that level. The purpose of this document is to review current and past aerial survey information to estimate TARs for walrus in Foxe Basin.

Walrus is a key fishery for DFO and is reported on via the national Sustainability Checklists. As part of this initiative, Resource Management is developing an Integrated Fisheries Management Plan (IFMP) for Atlantic walrus in the Nunavut Settlement Area. This will also assist Canada in responding to increasing national and international attention regarding how walrus are managed.

A Science Advisory Report (SAR) was published in 2013 (DFO 2013) that provided Total Allowable Removal (TAR) levels for several areas, including Foxe Basin (FB). Based on the science advice, the current level of harvesting in FB exceeds the TAR. DFO conducted community consultations and submitted a Request for Decision to the Nunavut Wildlife Management Board (NWMB) to establish sustainable harvest levels. During the consultations, it was brought to the attention of DFO that there was some information from the late 1980s that might be useful in evaluating the stock trend of FB walrus, and therefore might influence the recovery factor (F_R) that had been used in the advice (DFO 2013) when calculating the PBR for this stock.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recommended in 2006 that Atlantic Walrus be designated as a "Species of Special Concern." COSEWIC is currently re-assessing Atlantic walrus. The Atlantic walrus is currently listed on Appendix III of the Convention on International Trade in Endangered Species (CITES). As such, anyone wishing to export walrus parts or derivatives from Canada must obtain an export permit from the Canadian CITES administration. However, a non-detriment finding is not required for species listed on Appendix III of CITES. In 2009 and again in 2012, the United States consulted with range states on the possibility of putting forward a proposal to uplist walrus to Appendix II, citing

potentially unsustainable exploitation rates, lack of scientific information on population abundance, lack of a formal management plan, high value international trade in walrus ivory, and the difficulty in distinguishing fresh ivory from fossilized as some reasons for seeking increased protection. If listed on Appendix II, a non-detriment finding would be required for continued trade in this species.

Species Biology

The walrus (aivik, Inuktitut name) is Canada's largest pinniped. Both males and females are about 125 cm long at birth but adult males are significantly longer (315 cm) than adult females (277 cm). In both sexes, the upper canine teeth develop into long tusks that start to appear when the animal is about 2 years old. In adult males from Foxe Basin, tusks have averaged about 28.5 cm in length with a circumference at the base of about 16.7 cm. Tusks of females may be as long (~28.1 cm) but are more slender, with a base circumference around 13.2 cm. All walrus routinely haulout onto ice or land in all seasons and show a high degree of fidelity to haulout sites and feeding areas. It is thought that females and their young return to certain sites more faithfully than do adult males. Although some hauled out groups may contain animals of all ages and both sexes, walrus tend to segregate by age and sex most of the year. Walrus distribution is thought to be influenced not only by the availability of haul-out sites, but also shallow water for feeding on bivalve molluscs, their main prey, and other invertebrates. Most feeding is believed to take place in water less than 100 m deep although walrus can dive deeper. Some walrus also eat seals, a behaviour that may be more common when they do not have access to shallow water areas. Hunters distinguish seal-eating walrus by their yellow tusks. The mating system of walrus involves males competing for and defending access to females for mating for periods of up to five days. The mating season is in January to April. Implantation in the uterus appears to occur in late June to early July and the calf is born the following May-June. Age of first ovulation varies among populations, but is generally between 5-10 years. The calving interval is generally 3 years. The overall pregnancy rate among mature females is 35%.

ASSESSMENT

Evaluation of different methods used to estimate walrus abundance

Walrus are a challenging species to enumerate owing to their aggregated distribution and correlated haulout behavior resulting in highly variable numbers of animals hauled out at a time. Several methods have been used in the past to obtain a best count of animals hauled out during the survey. These counts must then be corrected for the estimated proportion of animals that were in the water when the survey was completed. In this assessment, simulation methods were used to examine the different methods of counting hauled out animals that have been used in the past as well as new estimators. It was concluded that the least biased method was to use the average count from haul-out sites that have been surveyed multiple times. These are referred to as Simple Counts (SC). The Simple Counts are adjusted for animals in the water when the survey was completed using the average proportion of animals hauled out. A new method explored a way of accounting for the fact that walrus tend to haulout together, i.e., there is some correlation among animals in their haulout behaviour, but more work is needed to implement the approach.

Surveys/Counts

Information from hunters, previous and ongoing research were used to identify walrus haulout areas prior to surveys being conducted. Surveys were flown to count walrus at haulout sites in

July-September 1983, 2010 and 2011. In addition two systematic strip-transect surveys were flown in July-August 1988, and 1989.

New Analyses

Although methods did differ, the surveys were viewed to be sufficiently comparable to provide useful information on walrus abundance in Foxe Basin. The estimates from 1982, 1988, and 1989 were verified and did not change. The 2010 and 2011surveys were previously presented as Minimum Counted Population and had been adjusted assuming that the proportion of animals hauled out was a maximum (p=0.74). Based upon conclusions from a simulation study, the data were re-analysed using the Simple Count method and adjusted assuming the average proportion of animals hauled out. Satellite transmitters had been deployed to estimate the proportion of animals that were hauled out at one time during the 2010 and 2011 surveys. For the two years, the mean proportion of animals hauled out was 0.37 (SE=0.16) based upon data from 19 satellite transmitters. This proportion was applied to all surveys.

A surplus production population model, that included reported harvest information was fitted to the Foxe Basin times series of abundance estimates (1983-2011) and reported harvests (1954-2014), using Bayesian methods. One of the strengths of the Bayesian approach is that it provides a framework to account for uncertainty in model inputs.

Reported harvests underestimate the number of walrus killed because of animals wounded or killed but not recovered ("Struck and Lost"), as well as an absence of harvest reports for some communities in different years. The harvest data for each year used in the population model were the sum of reported harvests for the communities of Igloolik and Hall Beach. Missing data for each community were interpolated by taking the average of the nearest 5 years of harvest for each community. The proportion of animals that were killed but not recovered, the struck and lost rate, was estimated by the model.

Walrus are considered to be data poor. The method used to calculate the Total Allowable Removal (TAR) levels is as follows:

$$TAR = PBR = N_{min} \cdot R_{max} \cdot 0.5 \cdot F_R$$

where: PBR is the Potential Biological Removal

N_{min} is the estimated minimum population size.

R_{max} is the maximum rate of increase for the population.

F_R is a recovery factor with values set to reflect known population status.

Estimates of N_{min} were calculated from the population size estimated by the population model, taking into account the uncertainty around this estimate.

In previous assessments, a maximum rate of increase (R_{max}) = 0.07 has been used. This review concluded that a R_{max} = 0.08 is more appropriate (United States Federal Register 2013).

The Department has previously recognized two criteria for the recovery factor F_R to use in PBR calculations. First, F_R = 0.5 should be used for stocks where there is evidence that abundance is declining – otherwise F_R = 1.0 can be used. Second, F_R = 0.5 should be used for populations with a conservation status considered to be threatened or endangered – otherwise F_R = 1.0 can be used.

Results

The different surveys covered the northern portion of Foxe Basin. All surveys overlapped in areas covered (Figure 2) and the estimates are reported in Table 1.

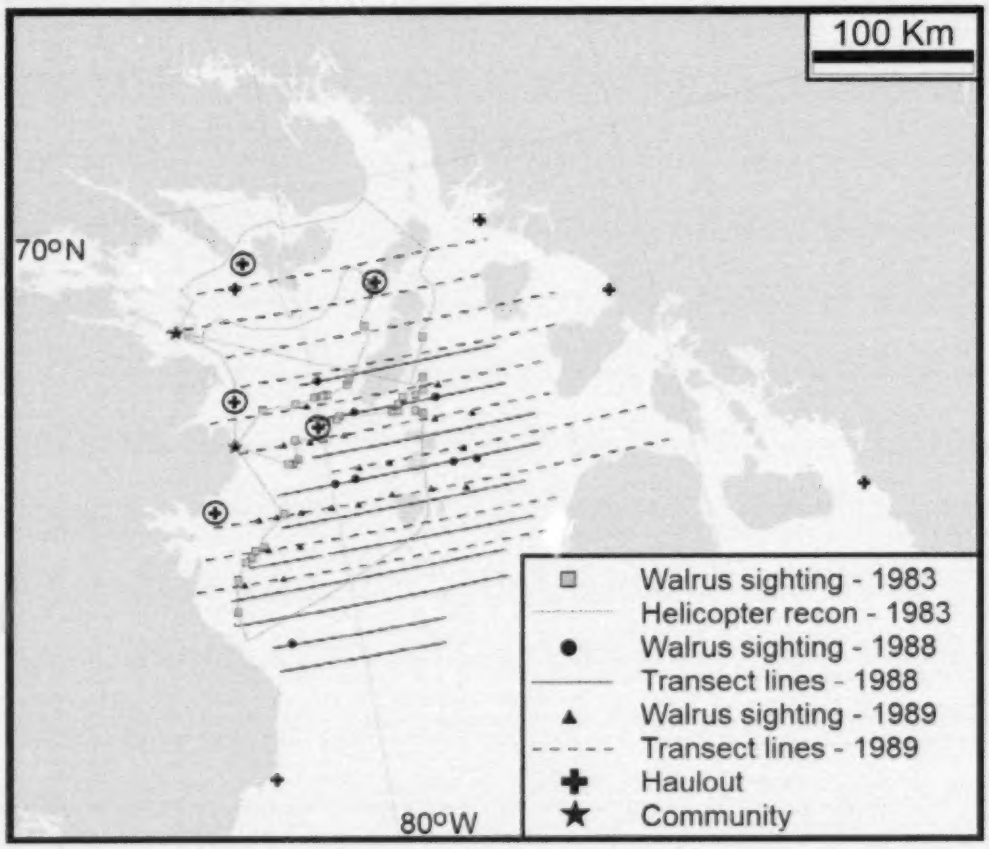

Figure 2. Comparison of survey coverage for the Foxe Basin walrus surveys conducted by DFO in 1983 (Orr et al. 1986), 1988 and 1989 (Richard unpubl. rep.; Richard et al. unpubl. rep.), and 2010 and 2011 (Stewart et al. 2013). The haulouts covered in the 2010-2011 surveys are identified by circles. Figure is from Stewart and Higdon unpubl. rep.

Table 1. Survey year, count/estimate, proportion of animals hauled out, and adjusted counts for walrus in Foxe Basin. Source where the original count data can be found, but counts were adjusted using a proportion hauled out of 0.37. Estimates are rounded to the nearest 100.

Year	Number (N)	SE (N)	Proportion hauled out	SE (P)	Adjusted Number	SE	Source
1983	2700		0.37	0.16	7400	3200	Orr et al. 1986
1988	5100	4400	0.37	0.16	13900	13300	Richard unpubl. rep.
1989	5500	1600	0.37	0.16	14900	7800	Richard unpubl. rep.
2010	3900		0.37	0.16	10400	4500	Stewart et al. 2013a
2011[a]	5200	1000	0.37	0.16	14100	6700	2011 data combined

[a] The 2011 estimate is the average of two counts [(4484+5945)/2] rounded to the nearest 100.

Population Model

Incorporating the time-series of abundance estimates with our understanding of the dynamics of walrus populations and harvests into a modeling framework showed that the population has likely remained stable over the last 60+ years (Table 1, Figure 3). From the model the estimated population in 1954 was 11,900 (95% BCI=10,200-17,900). The estimated 2014 population was 12,500 (95% CI = 8,600-18,500). The reported harvests do not appear to be having an impact on the population as it appears to be stable. However, our ability to detect a decline is limited.

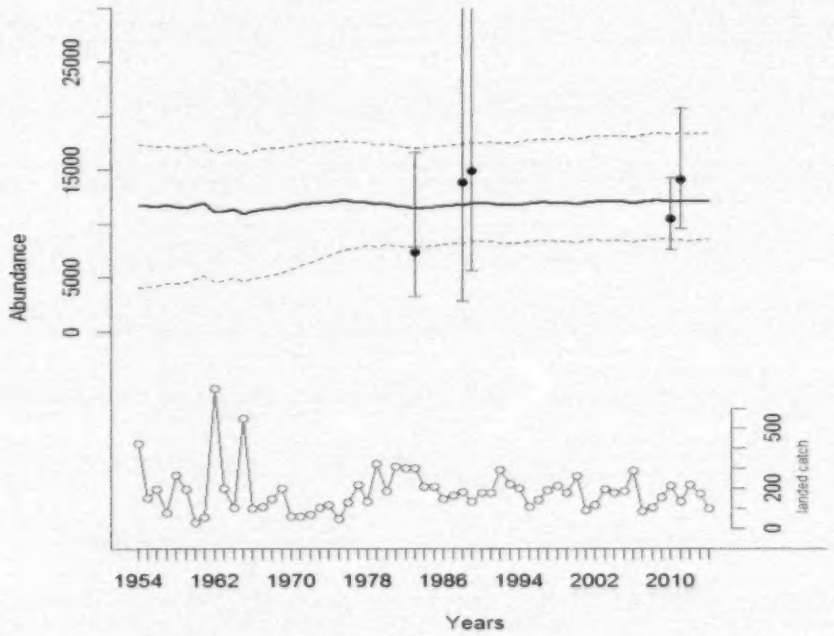

Figure 3. Model estimates of Foxe Basin walrus abundance (adjusted assuming that the proportion of the population hauled out was 0.37). Solid line: median estimates. Dashed lines: 95% Bayesian Credible Interval. The model was fitted to corrected aerial survey estimates (closed circles, ± 95% confidence interval assuming log-Normal distribution of standard error). Right y-axis: Reported catch of walrus from Igloolik and Hall Beach (open circles). (Updated from Stewart et al. 2014)

Reported harvests since 1954 have been quite variable, but without any trend. The mean harvest over the last 25 years (1989-2014) is 178 (SE=12) annually. Over the last 5 years (2010-2014), the annual harvest has averaged 170 (SE=25) animals annually.

Total Allowable Removals

The PBR estimated from the 2014 population estimate obtained from the population model would be 211 or 422 for F_R of 0.5 or 1 respectively. The PBR calculation includes the total number of removals from all sources of human induced mortality. Current average reported harvests from this area are 170 animals per year. If we assume a Struck and Lost rate of 30%, then the number of animals killed was 243.

Sources of Uncertainty

Walrus are widely distributed. The use of haulout sites can change seasonally and between years. Disturbance by boat activity at some haulout sites during the surveys can cause animals to disperse, which will lead to negatively biased estimates.

The abundance estimates reported here rely on correction factors developed from satellite transmitters deployed on relatively few animals and at few sites. There is some evidence that walrus haulout behaviour is correlated among animals, but the strength of this correlation is not well known.

It was assumed that walrus censused in Foxe Basin are only harvested in Foxe Basin and by the communities of Igloolik and Hall Beach. It is not known if animals from this stock are harvested outside of this area.

There have been few surveys to determine walrus abundance and those that have been completed did not always cover the same haulout sites, which add to uncertainty in overall estimate and modeling population trend.

Recent stock-specific information on struck and lost is very limited, and information on reported harvests is uncertain. In some years data are available, but the completeness of records is not known. The harvest data have an important impact on the results of the model and our understanding of population trends.

ADDITIONAL STAKEHOLDER PERSPECTIVE

Walrus are an important and vital subsistence species for the Inuit of Nunavut and Nunavik for a variety of cultural, economic, health and social reasons. Despite an increasing Inuit population, walrus hunting has declined since the 1980s, in large part due to a shift away from the use of dog teams. Inuit also report a lower stuck and lost rate, as low as 5%, which is lower than has been reported in the literature.

There is a concern in Igloolik and Hall Beach about disease and contaminants in walrus, particularly around areas of DEW Line Sites. Hunters tend to avoid hunting walrus near these sites. There is also concern about the effects of climate change and how it will affect the environment, walrus and other species.

CONCLUSIONS AND ADVICE

A population model fitted to survey data and taking into account removals from harvesting indicates that the Foxe Basin population has likely been stable over the last 60 years. The stock is not considered to be either threatened or endangered. This indicates that F_R =1.0 can be considered by co-managers for use in calculating PBR and consequently a PBR using both F_R=0.5 and F_R=1 are presented. Additional work should be conducted to define criteria for determining the F_R to be used in PBR calculations in future assessments.

OTHER CONSIDERATIONS

Management Considerations

The Foxe Basin stock was last surveyed in 2011. Model uncertainty increases with increasing time since the last survey, which affects our ability to evaluate the impact of harvesting on the population. Additional surveys also, over time, reduce our reliance on the 'historical' surveys as they are incorporated into the model.

Ideally a Precautionary Approach framework with clear management objectives can be established for walrus management. This process would also identify when other risk based evaluation processes would be used in the provision of advice. In the meantime, updating the model with new survey data and using model outputs to provide PBR estimates is likely to provide more consistent PBR estimates.

SOURCES OF INFORMATION

This Science Advisory Report is from the October 20-23, 2015 Annual Meeting of the National Marine Mammal Peer Review Committee (NMMPRC). Additional publications from this meeting will be posted on the DFO Science Advisory Schedule as they become available.

DFO. 2013. Estimates of Abundance and Total Allowable Removals for Atlantic Walrus (Odobenus rosmarus rosmarus) in the Canadian Arctic. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/034.

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